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Chemical Effectiveness of a Natural Deodorant Spray Formulated with Basil Leaf Extract and Lemon Extract as Antibacterial Agents

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ABSTRACT

This study focuses on the development of a natural deodorant spray to address body odor caused by bacterial activity in sweat. The formulation utilizes alum, basil leaf extract, and lemon extract, all known for their antibacterial properties. Three formulations were evaluated: F1 (alum and basil extract), F2 (alum and lemon extract), and F3 (a combination of all three). The formulations underwent physical testing, pH analysis, clarity assessment, skin irritation evaluation, and fabric compatibility tests. Results indicated that F1 demonstrated stability in pH and clarity, F2 offered a superior aroma, and F3 exhibited the strongest antibacterial efficacy with a balanced fragrance. All formulations were found to be non-irritating and safe for use. The combination of these natural ingredients demonstrates significant potential for producing eco-friendly and consumer-safe deodorant spray products, highlighting their effectiveness in combating body odor while maintaining user comfort and environmental sustainability.

Keywords: deodorant spray formulation, basil leaf extract, lemon extract, natural sources

1. INTRODUCTION

Indonesia, a tropical country with a hot and humid climate, faces significant challenges in maintaining personal hygiene and appearance. Excessive sweating in such conditions often promotes bacterial growth, leading to body odor.[1-6] While deodorant sprays containing synthetic chemicals are commonly used, growing concerns about their health and environmental impacts have spurred interest in natural alternatives. This study focuses on developing a natural deodorant spray using alum, basil leaf extract (*Ocimum basilicum* L.), and lemon extract (*Citrus limon*), all of which are known for their antibacterial properties. By leveraging these natural ingredients, the research aims to create an effective, eco-friendly deodorant solution that addresses body odor while minimizing adverse effects on health and the environment.[7-10]

Previous studies indicate that basil leaves (*Ocimum basilicum* L.), a plant widely distributed across Indonesia, are commonly used as a culinary ingredient and traditional medicine. In Indonesia, basil is

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widely used as a fooding, leaflet, and complementary vegetables. According to Aluko et al, belonging to the Lamiaceae family, basil contains various bioactive compounds, including phenols, flavonoids, tannins, saponins, alkaloids, and essential oils, which contribute to its antibacterial properties.[11] These characteristics make basil a promising candidate for use in deodorant formulations. It can also be used as an antibacterial agent in deodorants. Basil leaf essential oil, often processed into creams or liquids for ease of application, has demonstrated potential as an antibacterial agent. Additionally, basil leaves are rich in microminerals such as calcium, phosphorus, and magnesium, further enhancing their functional benefits. Similarly, lemon (*Citrus limon* Burm. F.) is known for its bioactive compounds, including flavonoids, limonoids, phenolic acids, and essential oils, with limonene (59.7% of its essential oil content) exhibiting significant antibacterial and antifungal activities.[1] These properties make lemon extract effective in inhibiting bacterial growth, a key factor in addressing body odor. Alum, another component in this study, is recognized for its astringent properties, which reduce skin moisture and inhibit bacterial proliferation.[12] Building on these findings, this research aims to evaluate the effectiveness of combining basil leaf extract, lemon extract, and alum in a natural deodorant spray formulation, offering a sustainable and health-conscious alternative to synthetic deodorants.

In this study, three deodorant spray formulations were developed and tested: F1 (basil leaf extract and alum), F2 (lemon extract and alum), and F3 (a combination of basil leaf extract, lemon extract, and alum). The hypothesis posits that the synergistic combination of basil leaf extract and lemon extract will yield an optimal antibacterial effect while providing a refreshing aroma, leveraging the antibacterial properties of their bioactive compounds and the astringent effect of alum. The research methodology encompasses the extraction of active ingredients from basil leaves and lemons, formulation of the deodorant sprays, and evaluation of their physical properties, safety, and efficacy. A key chemical interaction involves the metal ions from alum binding with the active compounds in basil and lemon extracts, enhancing their antibacterial activity. This approach builds on the established antibacterial potential of basil and lemon, as well as the moisture-reducing properties of alum, to create a natural deodorant spray that addresses body odor effectively while aligning with environmental and health considerations.[13-14]

2. EXPERIMENTAL

2.1. Chemicals, Equipment and Instrumentation

This study utilized a combination of natural extracts and chemical reagents to develop and evaluate deodorant spray formulations. The materials and equipment were selected based on their relevance to the extraction, formulation, and testing processes. Below is a detailed list of the chemicals were used in this research are Basil leaf extract (*Ocimum basilicum* L.) Lemon extract (*Citrus limon* Burm. F., $Al(SO_4)_2 \cdot 12H_2O$ Propylene glycol Distilled water and Litmus water.

2.2 Research Procedure

The extraction of basil leaves was conducted by boiling fresh leaves in distilled water for 30 minutes, followed by filtration using a sieve to obtain a clear and pure extract. Lemon juice was extracted by manually squeezing fresh lemons, and the resulting juice was filtered to remove pulp and impurities. Alum was dissolved in distilled water under constant stirring until a clear solution was achieved. Each ingredient was then combined according to the predetermined formulations: F1 (basil leaf extract and alum solution), F2 (lemon extract and alum solution), and F3 (a combination of basil leaf extract, lemon extract, and alum solution). The mixtures were stirred thoroughly using a magnetic stirrer until homogeneous. Subsequently, the formulations underwent physical testing, including pH measurement using a digital pH meter, clarity

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assessment through visual inspection, and skin irritation tests conducted on a small group of volunteers to ensure safety and efficacy. This systematic approach ensures the reproducibility and reliability of the formulations for further evaluation.

A. Extract basil leaves and Alum (Formula 1)

- Fresh basil leaves were washed thoroughly with clean water to remove impurities.
- The cleaned leaves were boiled in distilled water for 30 minutes.
- After boiling, the mixture was filtered using a sieve to separate the extract from the solid residue.
- The filtered basil extract was transferred into a sterile plastic container and allowed to cool to room temperature.
- Alum (50 g) was dissolved in 60 mL of distilled water under constant stirring until a clear solution was obtained.
- In a clean container, 10 mL of basil extract, 3 mL of propylene glycol (as a stabilizer), and the prepared alum solution were combined.
- The mixture was stirred thoroughly using a magnetic stirrer until a homogeneous solution was achieved.
- The homogeneous mixture was transferred into a deodorant spray bottle and allowed to settle for a few hours.
- The formulation was then subjected to a series of tests, including the organoleptic test, pH test, clarity test, skin irritation test, fabric effect test, and homogeneity test.

B. Extract Lemon and Alum (Formula 2)

- Fresh lemons were prepared and washed thoroughly to remove any surface impurities.
- The lemons were cut into smaller pieces and squeezed manually. The juice was then filtered using a sieve to remove pulp and seeds, yielding a clear lemon extract
- Alum (50 g) was dissolved in 60 mL of distilled water under constant stirring until a clear solution was obtained.
- In a clean container, 10 mL of lemon extract, 3 mL of propylene glycol (as a stabilizer), and the prepared alum solution were combined.
- The mixture was stirred thoroughly using a magnetic stirrer until a homogeneous solution was achieved.
- The homogeneous mixture was transferred into a deodorant spray bottle and allowed to settle for a few hours.
- The formulation was then subjected to a series of tests, including the organoleptic test, pH test, clarity test, skin irritation test, fabric effect test, and homogeneity test.

C. Extract Combination of Basil Leaf, Lemon and Alum (Formula 3)

- Fresh basil leaves, lemons, and alum were prepared as the primary ingredients.
- Basil leaves were washed thoroughly and boiled in distilled water for 30 minutes.
- After boiling, the mixture was filtered using a sieve to separate the extract, which was then collected and allowed to cool.
- Fresh lemons were cut into pieces and manually squeezed. The juice was filtered through a sieve to remove pulp and seeds, yielding a clear lemon extract.
- Alum (50 g) was dissolved in 60 mL of distilled water under constant stirring until a clear solution was obtained.
- In a clean container, 5 mL of basil leaf extract, 5 mL of lemon extract, and the prepared alum

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solution were combined.
- To the mixture, 3 mL of propylene glycol (as a stabilizer) was added, and the solution was stirred thoroughly until homogeneous.
- The homogeneous mixture was transferred into a deodorant spray bottle and allowed to settle for a few hours.
- The formulation was then subjected to a series of tests, including the organoleptic test, pH test, clarity test, skin irritation test, fabric effect test, and homogeneity test.

3. RESULTS AND DISCUSSION

3.1. Analysis of Characterization Results

A. Organoleptic Test

The organoleptic test was conducted to evaluate the physical characteristics of the deodorant formulations, including color, aroma, and homogeneity. The color was assessed through visual observation, while the aroma was determined by direct olfactory evaluation. Homogeneity was examined by visual inspection to ensure uniform distribution of components within the formulation. This test provides essential insights into the sensory properties of the product, which are critical for consumer acceptance and usability (Wulandari, 2019). The results of this evaluation are presented in the following sections.

Figure 1. Results of making deodorant spray with extra basil leaves and lemon

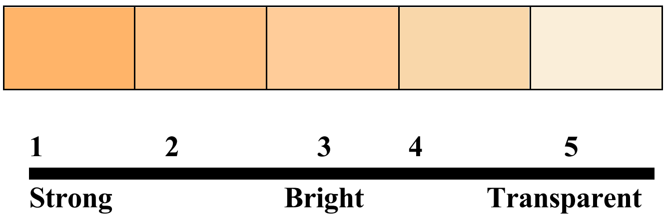

Figure 2. The color level produced in the deodorant spray formula

The color levels of the deodorant formulations were categorized into five distinct levels based on visual observation. Level 1 represents a solid yellow color, indicating a highly concentrated or opaque appearance. Level 2 is characterized as slightly solid yellow, showing a moderate concentration with some translucency. Level 3 is described simply as yellow, representing a balanced and distinct hue. Level 4 is light yellow, indicating a lighter and more diluted appearance. Finally, Level 5 is defined as light yellow with clarity, suggesting a transparent or nearly transparent solution with a faint yellow tint. These color

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gradations provide a systematic way to evaluate the visual properties of the formulations, which are essential for assessing their aesthetic appeal and consistency.

Table 1. Deodorant spray organoleptic test results

No.	Time	Organoleptic	Formula		
			F1	F2	F3
1	1 hour	Shape	Liquid	Liquid	Liquid
		Color	Slightly concentrated yellow	Solid Yellow	Bright Yellow: Clear
		Smell	No scent	Typical lemon	Typical lemon
2	2 hours	Shape	Liquid	Liquid slightly thickens	Liquid slightly thickens
		Color	Yellow	Slightly concentrated yellow	Light yellow
		Smell	No scent	Typical lemon	Typical lemon
3	3 hours	Shape	Liquid	Liquid Oily	Oily liquid
		Color	Yellow	Slightly concentrated yellow	Light yellow
		Smell	No scent	Typical lemon	Typical lemon
4	4 hours	Shape	Liquid Oily	Liquid Oily	Oily liquid
		Color	Light yellow	Slightly concentrated yellow	Yellow
		Smell	No scent	Typical lemon	Typical lemon
5	5 hours	Shape	Liquid Oily	Liquid Oily	Oily liquid
		Color	Bright yellow: Clear	Slightly concentrated yellow	Yellow
		Smell	No scent	Typical lemon	Typical lemon

Based on Table 1, the organoleptic test results for Formulas 1, 2, and 3 reveal distinct characteristics and changes over time, reflecting the interactions between their respective components. Formula 1, composed of alum and basil leaf extract, demonstrated stability in its liquid form throughout the testing period, with a gradual color change from slightly dark yellow to bright, clear yellow after 5 hours. This transition is likely due to the degradation of pigment compounds, such as flavonoids or chlorophyll, in the basil leaf extract, influenced by exposure to air or light.4 The absence of detectable odor further underscores the neutral nature of this formulation, as it lacks volatile fragrance compounds. These findings suggest that Formula 1 maintains its physical integrity over time, making it a stable option for further development.

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Building on these observations, Formula 2, which combines alum and lemon extract, exhibited more dynamic changes in texture and color. Initially liquid, the formulation thickened slightly by the 2-hour mark and transitioned to an oily consistency from 3 to 5 hours. This transformation is attributed to the reaction between lemon essential oils and water, leading to phase separation. The color evolved from deep yellow to a slightly less intense yellow, likely due to the homogeneous distribution of lemon pigment particles or partial precipitation. Notably, the distinctive lemon aroma remained consistent throughout the testing period, indicating the stability of volatile aromatic compounds like citral. These results highlight the influence of lemon extract on the physical and sensory properties of the formulation, providing a contrasting profile to Formula 1.

Expanding further, Formula 3, which incorporates alum, basil leaf extract, and lemon extract, displayed a combination of characteristics observed in both Formulas 1 and 2, with additional complexity due to the interaction of all three components. Similar to Formula 2, Formula 3 transitioned from a liquid to a slightly thickened and eventually oily consistency over time. The color shifted from bright, clear yellow to a more intense yellow by 4 to 5 hours, likely due to the oxidation of pigment compounds from both basil and lemon extracts. The lemon aroma remained dominant, suggesting that the aromatic compounds in lemon are more volatile compared to those in basil. These findings indicate that the combination of basil and lemon extracts in Formula 3 introduces a more intricate interplay of chemical reactions, resulting in unique physical and sensory properties.

In summary, the organoleptic test results from Table 1 demonstrate that each formulation exhibits distinct behaviors based on its composition. Formula 1 remains stable and neutral, Formula 2 shows dynamic changes influenced by lemon extract, and Formula 3 combines these characteristics with added complexity due to the interaction of multiple natural extracts. These insights provide a foundation for understanding how the components interact and influence the overall properties of the deodorant formulations, guiding further optimization and development.

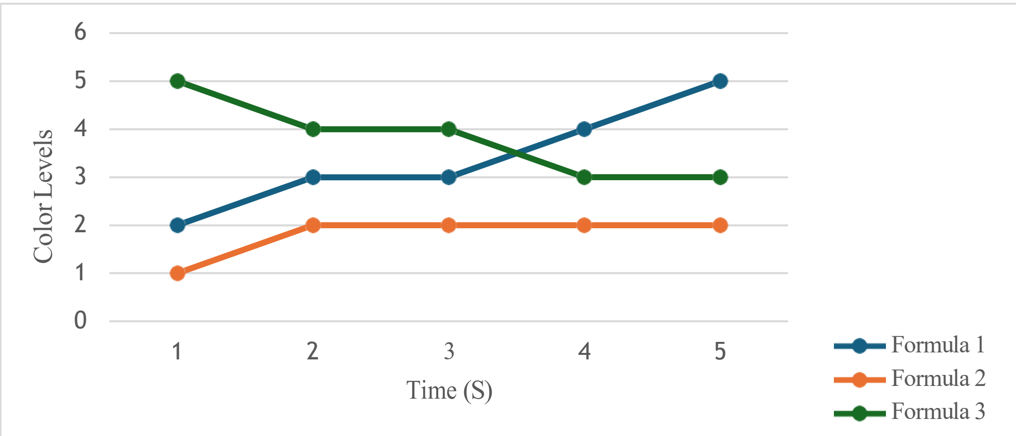

Figure 3. Color change over time

B. pH Analysis

The pH of a deodorant formulation is a critical quality parameter, as it directly impacts both product stability and user safety. A preparation is considered suitable for use if its pH falls within the predetermined optimal range (4.5–7). Extreme deviations, whether too acidic or too alkaline, can lead to skin irritation, making pH testing an essential step in evaluating the safety and efficacy of the product.

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Table 2. Average pH results of deodorant spray preparations

Formula	Observation					Parameter Criteria
	Day-1	Day-2	Day-3	Day-4	Day-5	
F1	7	7	7	7	7	4,5-7
F2	6,5	6,2	6,2	5,9	5,5	4,5-7
F3	5,3	5,2	5,2	4,9	4,7	4,5-7

Based on the pH test results in Table 2, the three formulations exhibited distinct behaviors over the 5-day storage period. Formula 1, composed of alum and basil leaf extract, demonstrated remarkable stability, maintaining a constant pH of 7 throughout the testing period. This stability can be attributed to the bioactive compounds in basil extract, such as phenolics and flavonoids, which possess natural buffering properties that help maintain pH levels. Additionally, alum (aluminum sulfate) contributes to pH stability by forming ions that neutralize fluctuations in acidity or alkalinity. The combination of these ingredients creates a formulation resistant to pH changes caused by environmental factors such as temperature or microbial contamination during storage.

In contrast, Formula 2, which combines alum and lemon extract, showed a gradual decrease in pH over the 5-day period, starting at 6.5 on day 1 and dropping to 5.5 by day 5. This decline is primarily due to the chemical properties of citric acid in lemon extract, which has a naturally low pH (2–3). During storage, the degradation of organic compounds such as vitamin C (ascorbic acid) in lemon extract can produce additional acidic compounds, further lowering the pH. Additionally, interactions between lemon compounds and alum ions may release hydrogen ions (H^+), contributing to the increased acidity. Storage conditions, including temperature and oxygen exposure, likely accelerated this process through the oxidation of organic compounds.

Similarly, Formula 3, a mixture of alum, basil leaf extract, and lemon extract, also exhibited a decreasing pH trend, starting at 5.3 on day 1 and reaching 4.7 by day 5. The decline in pH can be attributed to several factors, including enzymatic activity, oxidation of active compounds, and microbial influences. Lemon extract, with its high citric acid content, is prone to oxidation, which releases hydrogen ions and lowers the pH. Furthermore, phenolic and flavonoid compounds in basil extract may degrade due to exposure to oxygen, temperature, or light, further contributing to the pH reduction. The combination of these factors results in a more pronounced pH decrease compared to Formula 2, highlighting the complex interactions between the ingredient.

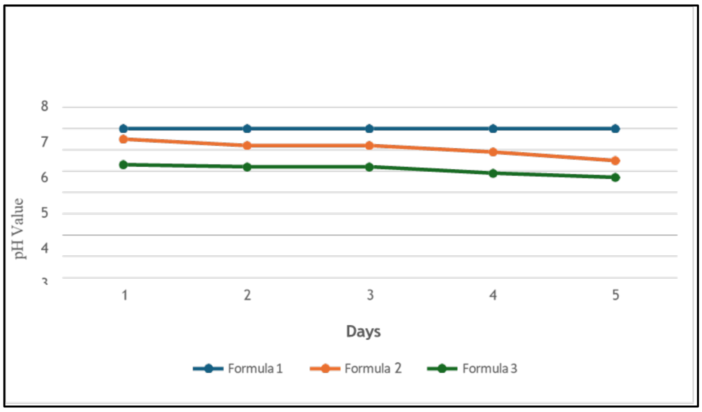

Figure 4. Average pH of Deodorant Spray

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C. Deodorant Spray Clarity Test

The clarity test was conducted on three different deodorant spray formulations over a 5-day period to evaluate their stability and visual appearance during storage. The results are summarized in Table 3, where a check mark (✓) indicates that the solution remained clear, while a dash (-) indicates that turbidity or cloudiness was observed.

Table 3. Deodorant Spray Clarity Test Results

Formula	Result				
	Day-1	Day-2	Day-3	Day-4	Day-5
F1	✓	✓	✓	✓	✓
F2	✓	✓	✓	✓	✓
F3	✓	✓	-	-	-

Based on the test results, the combination of basil extract and alum demonstrated excellent stability in Formula 1, maintaining clarity throughout the 5-day testing period. This sustained clarity can be attributed to two key factors: first, the antibacterial properties of basil extract, which contains active compounds such as flavonoids, tannins, and eugenol that serve as natural preservatives; and second, the coagulating properties of alum, which effectively precipitates suspended particles and maintains solution stability.

Similar to Formula 1, the mixture of lemon extract and alum exhibited consistent clarity over the 5-day period. The stability can be traced to the natural preservative action of citric acid in lemon extract, which provides antimicrobial activity against clarity-affecting microorganisms. Additionally, alum's coagulating properties complement this effect by binding to suspended particles, resulting in a consistently clear solution.

The triple combination of lemon extract, basil extract, and alum showed initial promise but failed to maintain long-term stability. While the solution remained clear for the first two days due to the combined antimicrobial effects of citric acid and basil compounds, along with alum's coagulating properties, clarity degraded from day 3 onward. This deterioration likely resulted from several factors: the gradual decline in antimicrobial compound effectiveness, potential interactions between organic compounds in the mixed extracts leading to precipitate formation, and the possible influence of environmental factors such as temperature and air exposure. These findings suggest that while simpler formulations (F1 and F2) maintained better stability, the more complex mixture in F3 may require additional stabilizing agents or modified storage conditions to achieve comparable long-term clarity.

D. Skin Irritation Test

Skin irritation testing is a crucial safety assessment for cosmetic products, particularly those applied directly to human skin like deodorant sprays. This evaluation method is considered the gold standard for detecting potential allergic reactions or skin irritation. The test protocol involves carefully selected panelists who meet specific criteria: healthy skin condition, no history of severe skin allergies, and absence of current medication use that could interfere with test results. Testing is conducted on designated areas of the body, typically the forearm or back, under controlled conditions.

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Table 4. Skin irritation test results

Formula	Time	Occurrence of Erythema	Occurrence of Edema	Irritation Index
F1	24 hours	0	0	No irritation
	48 hours	0	0	No irritation
	72 hours	0	0	No irritation
F2	24 hours	0	0	No irritation
	48 hours	0	0	No irritation
	72 hours	0	0	No irritation
F3	24 hours	0	0	No irritation
	48 hours	0	0	No irritation
	72 hours	0	0	No irritation

This study investigated three distinct deodorant formulations, each developed with a specific combination of natural and synthetic ingredients. Formulation 1 contained basil extract, alum, propylene glycol, and distilled water. Formulation 2 substituted the basil extract with lemon extract while maintaining the same base ingredients. Formulation 3 represented a more complex composition, incorporating both botanical extracts along with the base components. Observations over a 72-hour period demonstrated excellent skin compatibility across all formulations, with no signs of erythema or edema. This consistent performance warrants detailed analysis of the specific properties and mechanisms of each formulation.
The exceptional skin tolerance of Formulation 1 can be attributed to its well-balanced composition. Basil extract serves as the primary active ingredient, providing antioxidant and antimicrobial properties that support skin health. This activity is complemented by alum, which at controlled concentrations delivers its beneficial properties while maintaining skin compatibility. The addition of propylene glycol enhances the formulation through its moisturizing properties while preserving its mild nature.

Formulation 2 showed similar skin compatibility through the balanced interaction of its components. The natural acidity and vitamin C content of lemon extract are effectively moderated by the careful balance with alum and propylene glycol. The aqueous base ensures optimal delivery of active ingredients while maintaining skin comfort. Despite its more complex composition, Formulation 3 maintained equivalent skin compatibility. The synergistic combination of basil and lemon extracts provides a comprehensive approach, offering both soothing and antimicrobial benefits. The supporting ingredients ensure stable delivery of these active components while preserving optimal skin tolerance.

The consistent safety profile across all formulations can be attributed to several key development factors. Primary importance was given to precise concentration control, ensuring all ingredients were incorporated at levels validated for skin safety. The formulations were optimized to maintain pH values compatible with normal skin pH (4.5-7), minimizing potential irritation. The selection of botanical ingredients provides effectiveness while maintaining skin compatibility. Additionally, the exclusion of known irritants, including alcohol and harsh synthetic compounds, contributes to the favorable skin tolerance profile.

These findings demonstrate that all three formulations meet the safety requirements for topical deodorant preparations. The results support their effectiveness while maintaining skin health and comfort. This successful outcome validates the systematic approach to formulation development and ingredient selection, providing strong evidence for their suitability as safe and effective deodorant products.

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E. Effect Test on Fabric

A critical aspect of deodorant formulation assessment involves evaluating potential fabric interactions, specifically examining possible damage or alterations such as discoloration, staining, or fiber degradation. This evaluation helps ensure the product's compatibility with clothing materials during regular use.

Table 5. Results of the Effect Test on Fabrics

Formula	Time	Color Changes	Stain Changes
F1	1 hour	Slightly yellow fabric	Slightly yellowish fabric
	5 hours	No color change	No color change
	15 hours	No color change	No color change
F2	1 hour	No color change	No color change
	5 hours	No color change	No color change
	15 hours	No color change	No color change
F3	1 hour	No color change	No color change
	5 hours	No color change	No color change
	15 hours	No color change	No color change

Analysis of fabric interactions, as shown in Table 5, revealed distinct behavioral patterns among the three formulations throughout the 15-hour observation period. Each formula exhibited unique characteristics that provided valuable insights into their compatibility with textile materials. In the case of Formula 1, containing basil extract, alum, propylene glycol, and distilled water, initial fabric interaction was observed during the first hour of application. The formulation produced a slight yellowish discoloration and staining, primarily due to the oxidation of flavonoid compounds and tannins naturally present in basil extract. When exposed to air, these compounds underwent oxidation and interacted with the cellulose fibers in the fabric, leading to temporary color changes. Interestingly, the subsequent observation period of 5-15 hours showed no additional color or stain changes, suggesting that the active compounds remaining on the fabric surface had completed their oxidation process.

Formula 2, comprising lemon extract, alum, propylene glycol, and distilled water, exhibited notably superior fabric compatibility. Throughout the entire 15-hour observation period, no visible color changes or staining were detected. This exceptional stability can be attributed to the unique properties of citric acid present in lemon extract, which typically does not produce coloring residues on fabric. Moreover, the acidic nature of the formulation may actively inhibit oxidation reactions that commonly lead to fabric discoloration.

Despite its more complex composition, Formula 3, which combined both basil and lemon extracts with alum, propylene glycol, and distilled water, demonstrated excellent fabric compatibility. The absence of any discoloration or staining throughout the test period indicates a beneficial neutralizing effect between the components. The acidic properties of lemon extract appeared to effectively moderate the oxidation potential of the basil extract's active compounds, resulting in stable and favorable fabric interactions.

Beyond fabric interactions, comprehensive evaluation revealed additional significant characteristics of the formulations. All three maintained pH values within the skin-safe range of 4.5-7, confirming their suitability for topical application. While Formula 1 showed optimal stability in terms of pH and clarity, it lacked desirable aromatic properties. Formula 2 contributed an appealing citrus fragrance but demonstrated accelerated phase separation. Formula 3 emerged as the most well-rounded option, successfully combining optimal antibacterial activity with pleasant aromatic qualities.

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These comprehensive findings offer valuable guidance for future formulation optimization. Although all formulas meet essential safety requirements, each presents unique advantages that could be strategically applied for specific use cases. Particularly noteworthy is Formula 3's potential as a balanced solution, effectively combining fabric compatibility with desirable performance characteristics, making it a promising candidate for further development.

CONCLUSION

The comparative analysis of three deodorant spray formulations highlighted unique strengths. Formula 1 (basil extract) excelled in pH stability but lacked fragrance. Formula 2 (lemon extract) provided a pleasant citrus aroma but showed reduced homogeneity over time. Formula 3 (basil and lemon extracts) proved the most balanced, offering antimicrobial efficacy, fragrance, and stability. All formulations were safe for topical use, with skin-friendly pH levels (4.5–7) and no irritation. Formula 3 stands out as the optimal choice, combining stability, safety, and performance. Future research could focus on improving the stability of Formula 2 or enhancing the fragrance of Formula 1 while preserving their strengths.

REFERENCES

1. Chandra, D., Irianto Tampubolon, M., & Priltius, N. (**2023**). Formulasi Dan Pengujian Sediaan Deodorant Spray Yang Mengandung Ekstrak Daun Kemangi (Ocimum Basilicum L.) Terhadap Bakteri Staphylococcus Aureus. *Jurnal Siti Rufaidah*, *1*(4).
2. Hamka, H. N., Zahran, I., & Amri, R. (**2024**). Formulasi dan Uji Aktivitas Antibakteri Deodoran Spray Alami Kombinasi Ekstrak Daun Senggani (Melastoma malabathricum L.) dan Daun Bidara (Ziziphus mauritiana L.). *Jurnal Mandala Pharmacon Indonesia (JMPI)*, *10*(1), 144–157. https://doi.org/10.35311/jmpi
3. Handayani, R. P., Pusmarani, J., & Awaliyah Halid, N. H. (**2022**). Formulasi dan Uji Aktivitas Sediaan Deodoran Spray Ekstrak Daun Beluntas (Pluchea indica) Terhadap Bakteri Stphylococcus epidermidis. *Jurnal Pharmacia Mandala Waluya*, *1*(1), 7–12. https://doi.org/10.54883/jpmw.v1i1.46
4. Hendarto, D. (**2019**). Dahsyatnya daun kemangi, bawang putih, bawang merah, dan bengkuang bagi kesehatan. LAKSANA. ISBN 602407669X, 9786024076696.
5. Hidayati, N., Kurniasari, M., & Septyasari, A. F. (**2021**). Formulasi dan Uji Sifat Fisik Spray Anti Bau Kaki Minyak Atsiri Jeruk Lemon (Citrus limon Burm. F.). *Urecol Journal. Part G: Multidisciplinary Research*, *1*(1), 26–30. https://doi.org/10.53017/ujmr.35
6. Khasanah, R. A., Budiyanto, E., & Widiani, N. (**2015**). Pemanfaatan Ekstrak Sereh (Chymbopogon Nardus L.) Sebagai Alternatif Anti Bakteri Staphylococcus epidermidis Pada Deodoran Parfume Spray. *Pelita - Jurnal Penelitian Mahasiswa UNY*, *0*(1), 1–9
7. Kurniawan, K., Kusumasary, D. A., Estikomah, S. A., & Marfu'ah, N. (**2024**). Formulasi sediaan deodoran spray ekstrak daun sirih merah (Piper crocatum Ruiz&Pav) dengan variasi alum (tawas). *Pharmasipha : Pharmaceutical Journal of Islamic Pharmacy*, *7*(2), 1–10. https://doi.org/10.21111/pharmasipha.v7i2.10665
8. Mardelina, E., Mulyono, P., Putri, S. H., & Mardawati, D. E. (**2023**). Aktivitas Antibakteri dari Deodorant Spray Ekstrak Kulit Jeruk Nipis (Citrus aurantifolia) Terhadap Bakteri Penyebab Bau Badan Antibacterial Activities of Deodorant Spray with Lime Peel Extracts (Citrus aurantifolia) Against Body Odor Bacteria. *Biorefinery and Bioeconomy*, *1*(2), 68–77.
9. Maulana, T. A. N. (**2023**). Buku ajar teknologi dan formulasi sediaan semi-solid dalam bidang kefarmasian. CV. Mitra Edukasi Negeri. ISBN 6238319461, 9786238319466.
10. Muaris, H. (**2014**). Khasiat Lemon untuk Kestabilan Kesehatan. Indonesia: Gramedia Pustaka Utama.
11. Mursyid, A. M., Zulkarnain, I., & Khusnia. (**2023**). FORMULASI SERUM EKSTRAK DAUN KEMANGI (Ocimum basilicum. L) SEBAGAI ANTIOKSIDAN. *Makassar Pharmaceutical Science Journal*, *1*(2), 43–56. https://journal.farmasi.umi.ac.id/index.php/mpsj
12. Novita, W. (**2013**). Buku pintar merawat kecantikan di rumah. Gramedia Pustaka Utama
13. Oktaviana, M. I., Pahalawati, I. N., Kurniasih, N. F., & Genatrika, E. (**2019**). Formulasi Deodoran Spray dari Minyak Atsiri Daun Kemangi (Ocimum basilicum L) sebagai Antibakteri Penyebab Bau Badan (Staphylococcus epidermidis) Deodorant Spray Formulation of Essential Oil of Lemon Basil (Ocimum basilicum L.) Leaves as an Antibac. *Jurnal Farmasi Indonesia (Pharmaceutical Journal of Indonesia)*, *16*(02), 396–405.
14. Rahmanda, D., Khasanah, H. R., & Krisyanella. (**2024**). FORMULASI DAN UJI AKTIVITAS SEDIAAN DEODORANT SPRAY EKSTRAK ETANOL BUNGA KECOMBRANG (Etlingera elatior (Jack) TERHADAP BAKTERI Staphylococcus epidermidis. *Journal Pharmacopoeia*, *3*(1), 33–43.

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